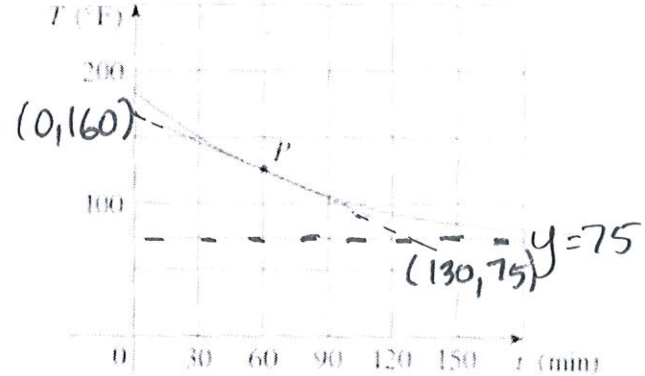
AP Calculus AB
Rate of Change

Name______________________________
Limits, Cont., & R.O.C Day 9

1. A roast turkey is taken from an oven when its temperature has reached $185^\circ F$ and is placed on a table in a room where the temperature is $75^\circ F$. The graph shows how the temperature of the turkey decreases and eventually approaches room temperature. By measuring the slope of the tangent estimate the rate of change of the temperature after an hour. Answers will vary



$$\frac{f(130)-f(0)}{130-0} = \frac{75-160}{130} \approx \frac{-85}{130} = -.654 \frac{{}^\circ F}{\text{min}}$$

2. The number N of US cellular phone subscribers (in millions) is shown in the table. (Midyear estimates are given.)

t	1996	1998	2000	2002	2004	2006
N	44	69	109	141	182	233

A.) Find the average rate of cell phone growth

i-from 2002 to 2006 $\frac{f(2006)-f(2002)}{2006-2002} = \frac{233-141}{4} = \frac{92}{4} = 23(\text{mill}) \frac{\text{cell phone subscrib}}{\text{year}}$

ii-from 2002 to 2004 $\frac{f(2004)-f(2002)}{2004-2002} = \frac{182-141}{2} = \frac{41}{2} = 20.5(\text{mill}) \frac{\text{cell phone sub.}}{\text{year}}$

iii-from 2000 to 2002 $\frac{f(2002)-f(2000)}{2002-2000} = \frac{141-109}{2} = \frac{32}{2} = 16(\text{mill})\ \text{subscrib}/\text{yr}$

In each case, include units.

B.) Estimate the instantaneous rate of growth in 2002 by taking the average of two average rates of change. What are the units?

$$\frac{20.5+16}{2} = 18.25\ \text{subscribers}/\text{year}$$

3. Let $T(x)$ be the temperature ($in\ °F$) in Phoenix t hours after midnight on September 10, 2008. The table shows values of this function recorded every two hours. What is the meaning of $T'(8)$? Estimate its value.

$$T'(8) = \frac{f(10)-f(6)}{10-6} = \frac{90°F - 75°F}{4\text{ hours}} = \frac{15°F}{4hr} = \frac{3.75°F}{hr}$$

The temperature is increasing approximately 3.75°F

hours t	0	2	4	6	8	10	12	14
temp °F T	82	75	74	75	84	90	93	94

per hour at 8:00.

4. The quantity (in pounds) of a gourmet ground coffee that is sold by a coffee company at a price of p dollars per pound is $Q = f(p)$.

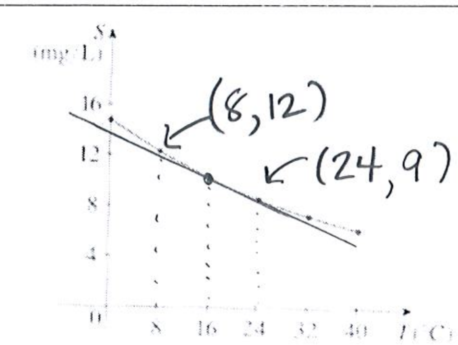
A.) What is the meaning of the derivative $f'(8)$? What are its units?

$f(p)$ = Quantity p = dollars $f'(8) = \frac{\text{Quantity}}{\text{dollars}}$ = cost for Quanity at 8 lbs.

B.) Is $f'(8)$ positive or negative? Explain.

At 8 lbs the cost should be decreasing.

5. The quantity of oxygen that can dissolve in water depends on the temperature of the water. (So thermal pollution influences the oxygen content of water.) The graph shows how oxygen solubility S varies as a function of the water temperature T.



A.) What is the meaning of the derivative $S'(T)$? What are its units?

$$S'(T) = \frac{\Delta y}{\Delta x} = \frac{\text{Oxygen Solubility}}{\text{water temperature}}$$

B.) Estimate the value of $S'(16)$ and interpret.

$$S'(16) = \frac{f(24)-f(8)}{24-8} = \frac{9-12}{16} = \frac{-3}{16} = -.1875\ \frac{(mg/L)}{°C}$$

As the temperature increases, the Oxygen solubility is decreasing at a rate of $-.1875$ mg/L/°C.

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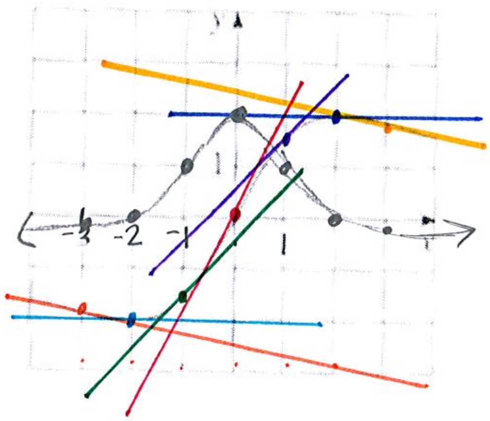

6. Use the given graph to estimate the value of each derivative. Then sketch the graph of f'.

Sketch ☺

A.) $f'(-3) = -\frac{1}{5} = -.2$ $(-3, -.2)$

B.) $f'(-2) = 0$ $(-2, 0)$

C.) $f'(-1) = 1$ $(-1, 1)$

D.) $f'(0) = 2$ $(0, 2)$

E.) $f'(1) = 1$ $(1, 1)$

F.) $f'(2) = 0$ $(2, 0)$

G.) $f'(3) = -\frac{1}{5} = -.2$ $(3, -.2)$

7. The unemployment rate $U(t)$ varies with time. The table (from the Bureau of Labor Statistics) gives the percentage of unemployed in the US labor force from 1999 to 2008.

x y

t	$U(t)$	t	$U(t)$
1999	4.2	2004	5.5
2000	4.0	2005	5.1
2001	4.7	2006	4.6
2002	5.8	2007	4.6
2003	6.0	2008	5.8

A.) What is the meaning of $U'(t)$? What are its units?

$$\text{Rate} = \frac{\Delta y}{\Delta x} = \frac{\text{unemployment Rate (\%) In US labor}}{\text{year}}$$

B.) Construct a table of estimated values for $U'(t)$.

$U'(1999) \approx \frac{4.0 - 4.2}{2000-1999} \approx -.2\%/\text{year}$

$U'(2000) \approx \frac{4.7 - 4.2}{2001-1999} \approx .25\%/\text{year}$

$U'(2001) \approx \frac{5.8 - 4.0}{2002-2000} \approx .9\%/\text{year}$

$U'(2002) \approx \frac{6.0 - 4.7}{2003-2001} \approx .65\%/\text{year}$

$U'(2003) \approx \frac{5.5 - 5.8}{2004-2002} \approx -.15\%/\text{year}$

$U'(2004) \approx \frac{5.1-6}{2005-2003} \approx -.45\%/\text{yR}$

$U'(2005) \approx \frac{4.6-5.5}{2006-2004} \approx -.45\%/\text{yR}$

$U'(2006) \approx \frac{4.6-5.1}{2007-2005} \approx -.25\%/\text{yR}$

$U'(2007) \approx \frac{5.8-4.6}{2008-2006} \approx .6\%/\text{yR}$

$U'(2008) \approx \frac{5.8-4.6}{2008-2007} \approx .6\%/\text{yR}$